

Hydraulics

3rd Year civil

First Term (2009 - 2010)

Chapter (   )

2009 - 2010

B. Home work

1- A channel has two sides vertical and semi-circular bottom of 2ms diameter. Calculate the discharge of water through the channel, when the depth of flow is 2ms. Take C=70 and slope of bed as 1 in 1000.

2- A sewer running half full is to be laid at a slope of 1/1000 to serve 200,000 persons at the rate of 300lit/person /day, considering n=0.016, find the sewer diameter if the maximum rate of flow according to which the sewer should be designed can be found by assuming that the total daily discharge flows uniformly in the sewer during 6 hours (not 24 hours).

3- A trapezoidal canal of side slope 1:1 and a bed width four times the depth, conveys $40m^3$/sec, is to be substituted by a semi-circular canal to convey the same discharge at the same velocity. Compare the bed slopes if n=0.012 in both cases.

4- Derive the conditions of the best hydraulic section for the triangular and circular sections.

5- Determine the dimensions of the most economical trapezoidal channel, n=0.016, to carry a discharge of 8000c.f.s with a slope of 12cm/km.

6- A canal having one side vertical and other side is sloping 3:2 caries a discharge of $20m^3$/sec, with a velocity of 0.5m/sec. determine the canal dimensions and its bed slope such that the section is hydraulically best (n=0.025).

7- Show that the maximum discharge in a circular open channel of a certain diameter takes place when the water depth is 0.95 times the channel diameter.

8- A special sewer consists of a semi-circular top and bottom of radius (r) joined by parallel vertical sides of length (2r) so that the total height is (4r), it is required to a) determine the angle subtended by water surface at the center of curvature of the upper semicircle to have maximum discharge, b) if the upper surface is raised until it reached the top of the sewer, find the percentage decrease in the flow.

يقطع هذا الكعب ويسلم مع حل التمرين للمعيد أو المدرس المساعد القائم بتدريس السكشن فى الوقت الذي يحدد له

اسم الطالب: الفصل: الرقم:

بسم الله الرحمن الرحيم

Home Work

Q(1):

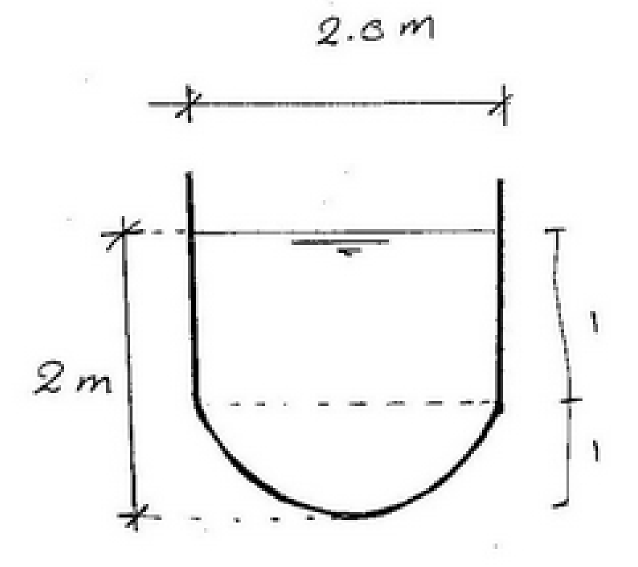
Req.:

Q = ??

Given:

C = 70

S = 1/1000



Sol.:

$$\because Q = C \times \frac{A^{3/2}}{P^{1/2}} \times S^{1/2}$$

$$A = (2 \times 1) + \frac{\pi \times (1)^2}{2} = 3.57 \ m^2$$

$$P = (1 + 1) + \frac{2\pi \times (1)}{2} = 5.14 \ m$$

$$\therefore Q = 70 \times \frac{(3.57)^{3/2}}{(5.14)^{1/2}} \times (1/1000)^{1/2}$$

$$Q = 6.60 \ m^3/S \ \#$$

Q(2) :

- $S = 1/1000$
- No. of persons = 200000
- rate = 300 lit/person/day
- $n = 0.016$
- Working time = 6 hrs

$y = \frac{d}{2}$

d =

Req.: $d = ??$

Sol.:

$$\because Q = \frac{1}{n} \cdot \frac{A^{5/3}}{P^{2/3}} \cdot S^{1/2}$$

$$\because A = \left(\frac{\pi}{4} d^2\right) \times \frac{1}{2} = 0.39\, d^2$$

$$P = \frac{\pi \cdot d}{2} = 1.57\, d$$

$$\because Q = \frac{\text{Volume}}{\text{time}}$$

$$\therefore Q = \frac{200000 \times 300}{(6 \times 60 \times 60) \times 1000} = 2.78\ m^3/s$$

$$\because\ 2.78 = \frac{1}{0.016} \times \frac{(0.39\ d^2)^{5/3}}{(1.57 d)^{2/3}} \times \left(1/1000\right)^{1/2}$$

$$\therefore\ 1.41 = \frac{0.21\ d^{10/3}}{1.35\ d^{2/3}}$$

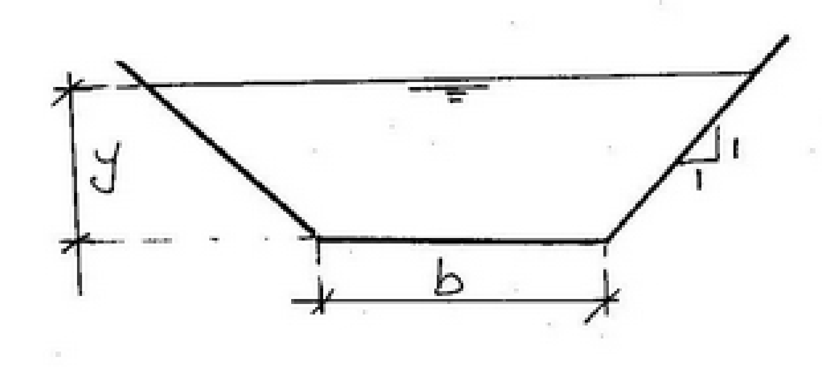
$$\therefore\ 9.1 = d^{8/3}$$

$$\therefore\ d = 2.30\ m\ \#$$

Q(3)

Given:

$b = 4y$

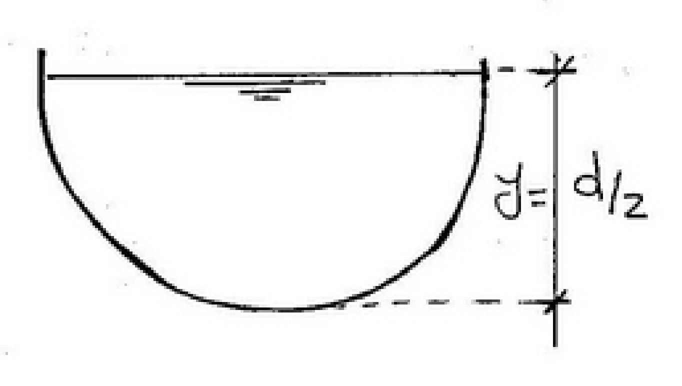


$Q = 40\ m^3/s$

$n = 0.012$

$Q_{Trap} = Q_{circle}$

$V_{Trap} = V_{circle}$



Req.: Compair bed slopes

Sol.:

$$\because Q_T = Q_C$$

$$\because Q = A \times V$$

$$\therefore A_{Trap} * \cancel{V_{Trap}} = A_{circle} * \cancel{V_{circle}}$$

$$\therefore A_{Trap} = A_{circle}$$

$$A_{Trap} = (b + Zy)y = (4y + y)y = 5y^2$$

$$A_{circle} = \left(\frac{\pi}{4} \times d^2\right) \times \frac{1}{2} = 0.4\, d^2$$

$$\therefore 5y^2 = 0.4\, d^2$$

$$2.24\, y = 0.63\, d$$

$$\therefore d = 3.60\, y \longrightarrow (1)$$

$$\because Q_{Trap} = Q_{circle}$$

$$\cancel{\frac{1}{n}} \cdot \frac{\cancel{A_T^{5/3}}}{P_T^{2/3}} \cdot S_T^{1/2} = \cancel{\frac{1}{n}} \cdot \frac{\cancel{A_C^{5/3}}}{P_C^{2/3}} \cdot S_C^{1/2}$$

$$\therefore \quad \frac{S_T^{1/2}}{P_T^{2/3}} = \frac{S_c^{1/2}}{P_c^{2/3}}$$

$$\because \quad P_T = b + 2y\sqrt{1+Z^2} = 4y + 2y\sqrt{1+1^2} = 6.82y$$

$$P_c = \frac{\pi \cdot d}{2} = 1.57\,d$$

$$\therefore \quad \frac{S_T^{1/2}}{(6.82y)^{2/3}} = \frac{S_c^{1/2}}{(1.57\,d)^{2/3}} \longrightarrow (2)$$

From (1) in (2)

$$\therefore \quad \frac{S_T^{1/2}}{(6.82y)^{2/3}} = \frac{S_c^{1/2}}{(1.57 \times 3.6y)^{2/3}}$$

$$\frac{S_T^{1/2}}{3.60\,\cancel{y^{2/3}}} = \frac{S_c^{1/2}}{3.17\,\cancel{y^{2/3}}}$$

$$\therefore \quad S_T^{1/2} = 1.14\,S_c^{1/2}$$

$$S_T = 1.30\,S_c \quad \#$$

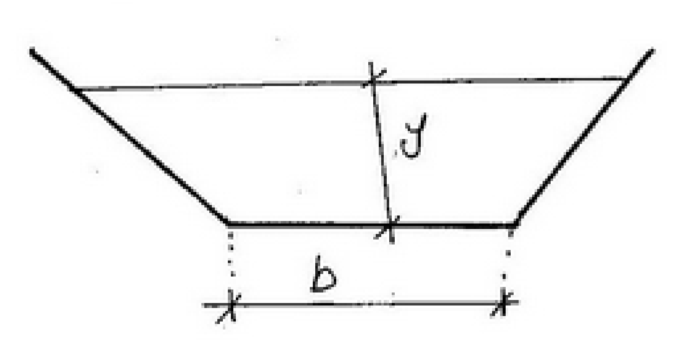
Q(5) :

Given :

$n = 0.016$

$Q = 8000\ ft^3/sec.$

$S = 12\ cm/Km$



Req. : Design B.H.S

Sol. :

$$\because Q = \frac{1.486}{n} \times \frac{A^{5/3}}{P^{2/3}} \times S^{1/2}$$

for B.H.S

$$R = \frac{y}{2}, \quad Z = 1/\sqrt{3}$$

$$\because A = (b + Zy)y = (b + \frac{1}{\sqrt{3}}y)y$$

$$\leftarrow A = (b + 0.58y)y$$

$$P = b + 2y\sqrt{1+Z^2} = b + 2y\sqrt{1 + (\frac{1}{\sqrt{3}})^2}$$

$$\leftarrow P = b + 2.3y$$

$$\therefore \frac{(b+0.58y)y}{(b+2.3y)} = \frac{y}{2}$$

$$\therefore 2b + 1.16y = b + 2.3y$$

$$\therefore b = 1.14y$$

$$\therefore A = (1.14y + 0.58y)y = 1.72y^2$$

$$P = 1.14y + 2.3y = 3.44y$$

$$\therefore 8000 = \frac{1.486}{0.016} \times \frac{(1.72y^2)^{5/3}}{(3.44y)^{2/3}} \times (12 \times 10^{-5})^{1/2}$$

$$\therefore 7863 = \frac{2.47y^{10/3}}{2.28y^{8/3}}$$

$$\therefore y = 28.00 \text{ ft} \quad \#$$

$$b = 32.00 \text{ ft} \quad \#$$

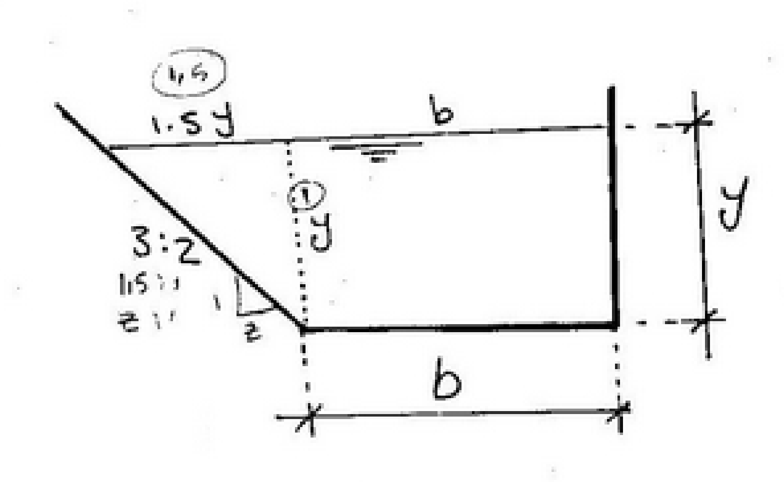
Q (6) :

Given:

$Q = 20\ m^3/s$

$V = 0.5\ m/s$

$n = 0.025$



Req. :

1- b , y for (B.H.S)

2- bed slope S

Sol. :

نظراً لأن القطاع ليس من القطاعات المعروفة فيتم اثبات الشرط الذى يجعل القطاع (B.H.S) أولاً ثم استخدام هذا الشرط فى الحل بعد ذلك.

$$\because \quad A = b \cdot y + \frac{1}{2} \times 1.5y \times y$$

$$\therefore \quad A = b \cdot y + 0.75y^2 \longrightarrow (1)$$

$\because \quad P = y + b + \sqrt{(1.5y)^2 + y^2}$

$= y + b + \sqrt{3.25y^2}$

$P = y + b + 1.8y$

$P = 2.8y + b \longrightarrow (2)$

from (1) $\quad b = \dfrac{A - 0.75y^2}{y}$

subis in (2)

$P = 2.8y + \dfrac{A}{y} - 0.75y$

$\therefore \quad P = \dfrac{A}{y} + 2.05y$

for B.H.S $\quad \dfrac{dP}{dy} = 0$

$\therefore \quad 0 = -\dfrac{A}{y^2} + 2.05$

$\dfrac{A}{y^2} = 2.05$

$A = 2.05y^2$

$$\therefore \quad b \cdot y + 0.75 y^2 = 2.05 y^2$$

$$b \cdot y = 1.30 y^2$$

$$\boxed{b = 1.3 y}$$

$$\because \quad Q = A \times V$$

$$20 = A \times 0.5 \quad \Rightarrow \quad A = 40 m^2$$

$$\because \quad b \cdot y + 0.75 y^2 = 40$$

$$\therefore \quad 1.3 y^2 + 0.75 y^2 = 40$$

$$\therefore \quad 2.05 y^2 = 40$$

$$\therefore \quad y = 4.42 \text{ m } \#$$

$$b = 5.75 \text{ m } \#$$

$$\because \quad Q = \frac{1}{n} \cdot \frac{A^{5/3}}{P^{2/3}} \cdot S^{1/2}$$

$$\therefore 20 = \frac{1}{0.025} \times \frac{(40)^{5/3}}{(18.13)^{2/3}} \times S^{1/2}$$

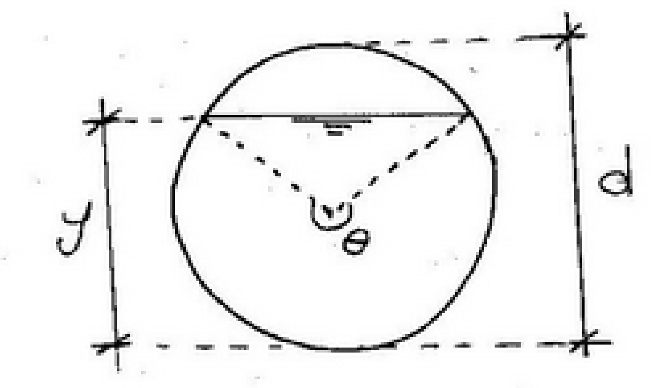
$$S^{1/2} = 7.37 \times 10^{-3}$$

$$S = 5.44 \times 10^{-5}$$

$$\therefore S = 5.44 \text{ cm/km} \ \#$$

Q(7) :

Drive that for Q_{max} in circular Canal $y = 0.95\,d$



Sol. :

$$\because\ Q = C \times A \times \sqrt{R \cdot S} = C \times A \times \sqrt{\left(\frac{A}{P}\right) \cdot S}$$

$$\therefore\ Q = C \times \sqrt{\left(\frac{A^3}{P}\right) \cdot S}$$

for Q_{max} $\quad \frac{d}{d\theta}\left(\frac{A^3}{P}\right) = 0$

$$\therefore\ \frac{A^3 \times \frac{dP}{d\theta} - P \times 3A^2 \times \frac{dA}{d\theta}}{P^2} = 0$$

$$\therefore\ A^3 \times \frac{dP}{d\theta} = 3PA^2 \cdot \frac{dA}{d\theta}$$

$$A \times \frac{dP}{d\theta} = 3P \times \frac{dA}{d\theta}$$

$$\because A = \frac{d^2}{8}(\theta r - \sin\theta) \longrightarrow 1$$

$$\frac{dA}{d\theta} = \frac{d^2}{8}(1 - \cos\theta) \longrightarrow 2$$

$$P = \frac{d}{2}\theta r \longrightarrow 3$$

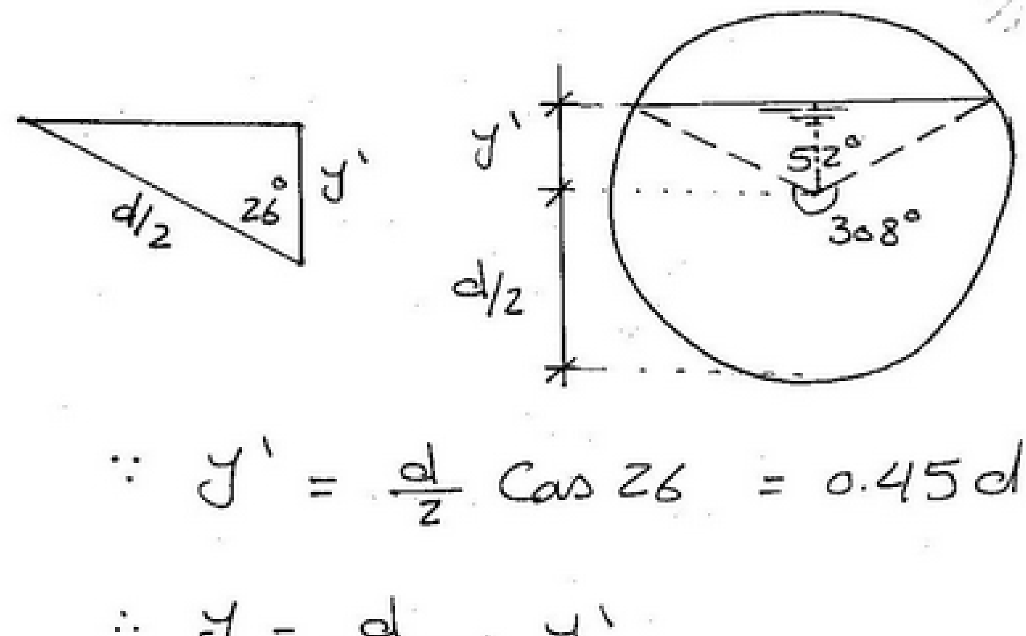
$$\frac{dP}{d\theta} = \frac{d}{2} \longrightarrow 4$$

$$\therefore \frac{d^2}{8}(\theta r - \sin\theta) \times \frac{d}{2} = 3 \times \frac{d}{2}\theta r \times \frac{d^2}{8}(1 - \cos\theta)$$

$$\therefore (\theta r - \sin\theta) = 3\theta r(1 - \cos\theta)$$

θ	200	250	300		
R.H.S					
L.H.S					

$$\theta = 308^\circ$$



$\because \; y' = \frac{d}{2} \cos 26 = 0.45d$

$\therefore \; y = \frac{d}{2} + y'$

$= \frac{d}{2} + 0.45d$

$\therefore \; y = 0.95d$ #